

Canadian Development and Commercialization of a North American Mobile Satellite Service

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ABSTRACT

Canada recognized early the value of mobile satellite communications, originally through the planning of a military system (MUSAT) and subsequently through the development of the Canadian MSAT system. Acting on behalf of the government, the Department of Communications (DOC) defined and carried out a complete plan for the implementation of Mobile Satellite Services (MSS). Based on an extensive dialogue between government, industry and users and encompassing all technical, economic regulatory and institutional aspects, this plan resulted in the completion by 1986 of a comprehensive business plan and a decision for commercial MSS delivery. The Canadian lead for a commercial system was quickly followed by others, and in particular the U.S., giving rise to the concept of North American MSS. In moving rapidly towards commercialization, we must learn from the past and plan for the future.

INTRODUCTION

Canada has been in the forefront of satellite communications for almost 30 years. In 1962, Canada became the third country in the world to launch a satellite and to pioneer satellite communications through Alouette 1, an upper atmospheric research satellite.

Although in intervening years surging international demands resulted in the proliferation of communications satellites, Canada continued to play a leading role in the development of new applications communications satellites. The DOC teamed up with the U.S. National Aeronautics and Space Administration (NASA) in the development and launch in 1976 of the Communications Technology Satellite (CTS), a direct broadcast satellite. Again, in the 1970's, the DOC in cooperation with the Canadian Department of National Defence (DND) and other government departments, developed the concept of a Canadian multi-purpose UHF satellite communications system called MUSAT. This system was conceived as the most cost-effective means of satisfying government needs for voice and data communications with ships, aircraft, vehicles and transportable stations operating in the Canadian north and other areas where conventional terrestrial systems could not provide services for technical and economic

reasons. The MUSAT system would have operated in the 240-400 MHz band which is used extensively in both Canada and the United States for military communications and was the forerunner of MSAT.

At the 1979 WARC, the decision was taken to permit shared satellite and terrestrial communications services to mobile radio and telephone users in the 806-890 MHz frequency band in Region 2 (North and South America). This new allocation allowed the benefits of mobile satellite communications to be extended to the general public and non-military government applications in such areas as oil exploration and exploitation, mining, trucking, shipping, business, personal communications, law enforcement, forest fire fighting, ambulance communications and resource management in remote areas. The availability of mobile satellite communications to the public at large was of distinct interest in view of the Canadian topography. The DOC re-directed its efforts to conduct preliminary studies in cooperation with NASA in early 1980 on the use of satellite technology in the provision of public mobile communications services in Canada and the U.S. These studies explored system concepts and gave strong indications that market demand would be sufficient to ensure the future commercial viability of satellite systems providing services to mobile terminals if the required technology and services were developed.

Thus the main emphasis shifted to minimizing or eliminating the technical, commercial and administrative risks involved. In effect, the government invested approximately \$20M, during 1982 and 1983, in order to fully justify the \$200M-\$300M implementation expenditure involved.

The government absorbed the complete cost of these studies since, under the original program direction, government was to be the main investor and owner of a demonstration MSAT system. The private sector's subsequent expression of interest in eliminating the demonstration system and moving directly to a commercially funded and owned system was in line with the strategic objectives defined for the Program at the outset. In fact, the private-sector interest in a commercial system was proof that the original targets of the Program had not only been met, but were exceeded. In 1984,

Telesat Canada assumed the role of the satellite owner and operator, and later transferred this role to a subsidiary Telesat Mobile Inc. (TMI).

This change in program direction did not significantly affect or alter the original objectives, although it did increase the strategic importance of the market and economic viability studies as well as the expedient implementation of the appropriate regulatory, institutional and international arrangements.

CANADIAN MSAT PROGRAM DEVELOPMENT

Program Objectives

There are two primary objectives governing the Canadian MSAT Program:

- 1) The development and availability of efficient and diverse mobile communications services in underserved areas of Canada; and
- 2) The creation of the necessary conditions under which Canadian domestic industry can develop and market effectively MSAT services and products domestically and internationally.

Although preliminary studies were encouraging, there still prevailed considerable skepticism as to whether or not the state of the art was sufficiently advanced as to permit the introduction of such services at realistic cost and risk. In this environment, it was essential to the achievement of objectives that the key collaborators be assured of reasonable risk-benefit tradeoffs. In the case of government it was important to show that the overall socio-economic benefits justified the expenditure of the public funds required for technology development and risk-sharing programs. Service providers had to be reasonably assured of sufficiently attractive returns on investment that would outweigh the higher than normal risks involved. Finally, manufacturers had to be reasonably assured that near term research and development outlays would translate into long-term portfolio and revenue gains.

Program Structure

Given the environment, it was evident that the DOC would have to provide much more than technical, financial and institutional support. What was required was an all-encompassing BUSINESS PLAN for the Development and Commercialization of Mobile Satellite Services (MSS), to be developed and managed by DOC on behalf of one of the main players (government) in consultation and cooperation with the other two (service and manufacturing industries). The resulting structure entailed numerous elements, with the main ones being:

- 1) system and service definition
- 2) user indoctrination and interaction
- 3) market definition and development
- 4) development of enabling technologies
- 5) overall commercial viability and socio-economic benefit evaluation
- 6) domestic regulatory and institutional arrangements
- 7) government risk-sharing support
- 8) international coordination and cooperation

The intent was for this BUSINESS PLAN to be fully executed in the five-year interval 1982-1987, with the ultimate success criterion of handing Program leadership over to the private sector at the end of that period.

System and Service Definition: Early in the program evolution, it was recognized that MSAT was unlike any other telecommunications system previously implemented which catered to point-to-point telecommunications. This was, indeed, a **Telecommunications Distribution Network** of end-user mobile satellite services similar, in many respects, to the telephone network.

Thus, two early documents were prepared, one dealing with a proposed system concept,¹ and the other defining a strawman services and applications scenario.² The system concept served as the main source document for the numerous technical system studies carried out in-house and through contracts let to the private sector. The strawman service description formed the basis of an unprecedented program of end-user indoctrination and interaction. It is interesting to note that the main service concepts contained in the strawman document have withstood the test of time and form the basis of presently proposed services and applications.

User Indoctrination and Interaction: In the 1982-1984 timeframe, user and service provider awareness of the potential of MSS was lagging considerably. The user audience to which the services were addressed was primarily familiar with private network radio communications and the majority of prospective MSS service providers were primarily familiar with point-to-point satellite communications. DOC initiated an intensive indoctrination program reaching hundreds of potential user organizations across Canada. Some two hundred of these became sufficiently interested as to enter into a continuing dialogue with DOC. This dialogue resulted in a broad base of educated users on one hand and on the other provided invaluable feedback on potential service refinements and improvements that were instrumental in finalizing the repertory of MSS services presently advocated. The user interaction resulted in a further originally unexpected benefit. Due to the broad user base involved and the close interaction, extremely detailed market demand and cost-sensitivity projections were obtained. In many respects, these projections proved to be more accurate and meaningful than the information compiled through statistical market and cost-sensitivity studies. For instance, the first indication of the now proven large demand for message oriented and other data services first became apparent through the user interaction process. Early user involvement has proven an invaluable tool in system and service evolution.

Market Definition and Development: Apart from the market and cost sensitivity obtained through the user interaction, a major statistical study was carried out by Woods Gordon Management Consultants.³ This study was primarily based on feedback received from an extensive mailed questionnaire and a limited number of interviews. Although the questionnaire format failed to reveal certain characteristics and aspects of the market, such as the issue of data services previously mentioned, it constitutes, nonetheless, the most

extensive independent market analysis available and its findings, modified through subsequent experiences, formed the basis for the commercial viability and socio-economic benefit assessments.

In addition to the overall market potential the Woods Gordon study provided inputs on the cost sensitivity of the MSAT services indicating the percentage of the potential market to be captured if the services were to be priced according to a number of pricing alternatives. Based on the above and after applying certain correction factors, to account for information made available at a later time or received from other sources, TMI developed the "baseline" market scenario used in the business plan.⁶

While market definition and sensitivity studies provide a good indication of potential commercial viability, the actual rate of market penetration is highly dependent on the early development of a broad user base. This is especially true in the case of MSS where the lag between system and service definition and actual implementation is very large. Recognizing this, the DOC defined and sponsored a program of trials and experiments aimed at generating user awareness and allowing potential end-user service providers to develop specialized services and products. This program is still ongoing and is dependent on the procurement of airtime on satellites of opportunity. While extremely well received this program has not reached its full potential due to uncertainties associated with the procurement of adequate airtime and overall program delays that have impacted user confidence.

Development of Enabling Technologies: For all the emphasis paid on other elements of the Program that helped define and justify the overall business plan, technology development consumed the bulk of the budget and resources of the program. Over twenty major studies were commissioned on space and ground segment development.⁴ Major attention was paid to payload, user terminal and UHF antenna technology considered critical in the formulation of the overall business plan. In parallel, extensive in-house research has been and continues to be carried out at the Communications Research Centre (CRC) of the DOC on both digital and analogue vocoder development. A major portion of the products of this development has been already passed on to industry.

By virtue of catering to the expedient development of a Canadian commercial system, technology development has focused primarily on near term development targets. As a result, second generation requirements have only just started to receive serious attention.

The most significant results, to date, have been accomplished in the area of payload development with SPAR Aerospace holding a prominent place amongst international satellite manufacturers.

Overall Commercial Viability and Socio-Economic Benefit Evaluation: The effect of the Program on a number of sectors had to be assessed in order to arrive at an overall evaluation of the impact of MSS introduction. Key areas evaluated were the impact on the communications industry as a whole,^{5,6} the commercial viability for the implementors of MSS,⁷ the impact on the

manufacturing industry,⁸ and the end-user benefits.⁹ It being crucial that these evaluations were realistic and unbiased, the DOC chose to task the principals, wherever possible, in the conduct of the required studies. Using these studies as an input, overall socio-economic assessment¹⁰ was carried out. The results were interesting, although predictable. Users of MSS stood to gain the most and the fastest; Communications Carriers could expect very good long-term returns after a somewhat bumpy ride initially; the potential markets generated for equipment suppliers were extremely large but subject to keen competition; and finally, the overall benefits to the country promised to be very substantial thereby fully justifying government financial support and risk-sharing.

Regulatory and Institutional Arrangements: Given the extremely encouraging results from other elements of the program, the DOC moved quickly to resolve the regulatory and institutional issues involved. Within the framework of existing domestic communications policy and regulations the following actions were taken: TMI was designated as the sole satellite owner and operator; a framework for end-user service distribution was established; and guidelines for the appropriate regulatory policies were issued. Suddenly the issue of frequency allocations became the only remaining unresolved piece of the puzzle.

Ever since the inception of the Program, a domestic frequency allocation at 800 MHz was taken as a given. In the euphoria created by the allocations obtained at the 1979 WARC, certain major issues pertaining to the adequacy of spectrum and the difficulties of bilateral coordination were partially overlooked. Suddenly it became apparent that the planned Canadian use of the very limited UHF spectrum available at 800 MHz would be subject to long and arduous negotiations between the Canadian and American administrations. As a result, the search for additional or alternate spectrum began again in both Canada and the U.S. with attention directed at the 1.5 GHz band. But the results of this search could not be known prior to WARC-MOB 1987. With all other aspects of the domestic MSAT business plan in place, government and industry agreed to finalize and publicly announce, in early 1986, the implementation decision for the domestic MSAT system, subject to adequate spectrum allocations in the 1987 time frame.

Government Risk-Sharing Support: Key to the final decision for MSAT implementation were the official endorsement and submission by TMI of a comprehensive Business Proposal,¹¹ and an extensive Cabinet Document prepared by DOC. In April 1986, the government approved a support package containing the following major items:

- 1) approximately \$30M of 50¢ dollars for the development of MSAT space and ground segment products;
- 2) up to \$20M for the sponsoring of user trials; and
- 3) a \$126M guaranteed lease for MSAT services to be procured from TMI over the life of the first generation system or a period of 15 years, whichever is longer.

Assessment of the MSAT Business Plan Development: By virtue of its charter to be the

chosen government instrument for both communications technology development and regulatory and institutional policies, DOC was in a position to define, develop, and justify a complete Business Development Plan.

Under this Plan, and having proved technical feasibility, commercial viability and overall socio-economic benefits, the DOC succeeded in putting in place the following commercialization enabling arrangements.

- a satellite owner and operator was selected and assured of a licence as early as 1983;
- an original domestic spectrum decision was taken as early as 1982 and modified in 1986 as a result of the associated FCC rulemaking;
- key players for the space and ground segment were identified as early as 1983;
- the types and levels of government support and incentives required to reduce risk were developed; and
- Program implementation received final approval by April 1986

All of the above helped define the set of key players and the form of the playing field, thus allowing the cooperative evolution of detailed systems and service parameters, a proposed service distribution scenario and a unified government and private sector front in international negotiations and coordination matters. Technical-economic tradeoffs were considered early. For instance, even though the technical feasibility of large spacecraft antennas was already demonstrated and the DOC was proposing antennas as large as 10 meters in diameter, it became apparent that both manufacturers and service providers were not prepared to adopt them for the first generation on the grounds of cost and risk. Other countries have since adopted a similar cautious approach on their proposed and, about to be, implemented systems.

Effective April 1986, the Canadian MSAT Program has been turned over to the private sector with DOC maintaining a support and oversight role. This is one year prior to the originally anticipated date and could have occurred as early as 1985 in the absence of spectrum availability complications.

Finally, commercialization of the Canadian Program acted as a catalyst for the acceleration of commercial plans in the U.S.

International Cooperation and Coordination: Throughout the MSAT Program development the DOC engaged in numerous cooperative arrangements involving domestic and international collaboration. Major domestic cooperative arrangements were executed with Telesat Canada first through a Memorandum of Understanding (MOU) subsequently replaced by a Joint Endeavour Agreement (JEA). Similarly, an MOU was executed between DOC and Spar Aerospace. Internationally, by far the most notable cooperation has been that with NASA, officially governed by the conditions contained in the NASA/DOC MOA executed in 1983. However the NASA/DOC cooperation is primarily a long standing association which has extended over a period of 20 years and is expected to continue in the 1990's at least as far as the present and future generations of MSS are concerned.

DOC's mandate further extends in the areas of international coordination. In this capacity DOC represents Canada in international fora such as the ITU and CCIR and in bilateral and multilateral negotiations such as frequency coordination, reciprocal operating agreements, etc. In this capacity, DOC has maintained a continuous interface with the FCC on MSAT Program matters, holds frequent meetings on MSAT spectrum coordination with INMARSAT, the U.S.S.R. and the U.S. and speaks on behalf of Canada in the ITU. These meetings which are de facto intense and partisan, have once again demonstrated that even the 1.5-1.7 GHz allocations established in 1987 are not sufficient to meet all reasonable domestic and international demands. Clearly the WARC-MOB 1992 will be faced with renewed demands for additional MSS allocations.

NORTH AMERICAN MSAT DEVELOPMENT

The difficulties encountered with the frequency allocations in the 800 MHz band were a sobering experience for Canada and possibly NASA. These difficulties did act, however, as a silver lining in that they generated wide awareness of the limited resource environment and of the need to think in terms of a North American MSS as opposed to individual national programs. This concept had certainly been considered by DOC and NASA in the past, but might have not been easy to sell to the regulators and the entrepreneurs but for the spectrum crisis that developed. As a result, there developed strong synergies between private sector counterparts in Canada and the U.S. as well as between the two administrations.

Finding themselves in a clearly underdog position prior to WARC-MOB 87, the two administrations aligned their positions and embarked on a worldwide campaign to generate international support for their proposal to generalize the existing mobile satellite allocations in the 1.5 - 1.7 GHz bands. Although not all of the Canada/U.S. proposals were accepted in the WARC-MOB 87, the resulting modifications contained in the final acts of the conference must be regarded as a victory, given the strong opposition provided by most European administrations and others.

The would be MSS providers in both Canada and the U.S. also moved quickly to endorse the North American service concept. Spectrum shortages were amongst the leading factors but the process was also assisted by the fact that U.S. MSS hopefuls found it expedient to align their efforts with those of TMI who was already the designated Canadian satellite owner and operator. Finally, both sides had a lot to gain by minimizing their initial capital expenditures. For whatever reasons, the present common approach towards MSS development makes immanent sense. The recent signing of a Joint Operating Agreement between TMI and the American Mobile Satellite Corporation (AMSC) is a major step towards the long overdue implementation of MSS in North America. While there are still outstanding issues remaining, it is reasonable to assume that these will be resolved in an expeditious manner; there is just too much competition domestically and internationally to afford the luxury of further major delays.

The DOC, in its continuing role of support, oversight and policy implementation, will continue to fully support and encourage the quick implementation of MSS in North America.

LESSONS LEARNED

Successes and Failures

There have been numerous accounts of the Canadian MSS development and, for his part, this author vows that this is his last attempt at a post mortem. MSS is well on the road to maturity and should be treated accordingly. For these reasons, a moment of reflection is well in order.

It is perhaps an overlooked fact that the MSS development has signalled the end of infancy for satellite communications services, for prior to MSAT and for all the mystique of space, satellite systems remained a glorified form of carrier or cable systems. For the first time, a satellite-based system had to cope with end-user service and all the complexities involved in the interconnection, distribution and control of a large communications network. The trend is irreversible! More and more future satellite service offerings will involve total network approaches.

The realization followed naturally but not without considerable strain that implementation decisions should not be left solely in the hands of satellite designers but instead should be strongly influenced and guided by service, network and marketing experts. The total network and service design concept was born.

Upon reflection, the single most important outcome of the approach adopted was the early involvement of the end-users and the end-user service providers in an iterative process that proved invaluable. The message was very clear: "MSS is from the people and for the people". Such mass consultations usually tend to become cumbersome and ineffective unless properly orchestrated. For this reason, the formation of committees was limited to a minimum, most of the dialogue being on a one to one basis. Ultimate control remained with the program planners.

DOC's wide jurisdictional powers on telecommunications coupled with the prevailing Canadian communications policies were instrumental in the development and implementation of an integrated Business Development Plan that resulted in the resolution of all Canadian domestic issues in the short period of 3 years. In a contrast in styles, the MSAT development in the U.S. depended upon the respective jurisdictions of NASA, FCC and to a certain degree NTIA with a resulting much longer interval of completion. The inherent merits of the two styles not being the issue, it is undoubtedly clear that prompt Program implementation was the result of the ability to embrace all Program activities within a single entity.

While recalling the many bright points of the Program, one cannot but temper them with the recognition of things not so well accomplished. Domestically the area that is lagging the most is the emergence of a strong manufacturing base for ground

segment equipment. For all the intensive research carried out by the DOC, for all the incentives and in contrast to the satellite manufacturers, this sector has been reluctant to commit to a long range portfolio development choosing to focus instead on short-term product development. As a result, the area most lagging today is that of network and user equipment development.

Finally, the handling of spectrum issues leaves a lot to be desired. Undoubtedly, the most frustrating and damaging to the Program development have been the years 1985-1987 during which spectrum availability was in serious jeopardy. Not only did user confidence sink to a low but in addition, this period was marked by the emergence of a number of competing systems and services.

Paradoxically, the total violation of the old and proven saying of not counting one's chickens before they are hatched may have proven to be the Program's silver lining! The development of MSS was based on the perceived availability of mobile spectrum at 800 MHz. But for this perception, it is highly unlikely that NASA and DOC would have embarked so vigorously on the MSAT Program development. In the absence of such commitment, it is questionable if the North American private sector would have been ready to commit to any form of cooperative program development, or if the Canadian and U.S. administrations would have pushed as hard as they did at WARC-MOB 87 or if the rest of the world would have been willing to take seriously any attempts to modify the existing mobile satellite allocations at 1.5 - 1.7 GHz. What could have been the greatest blunder in North American MSS development turned out to be a blessing in disguise.

But the spectrum lesson must remain with us because the future success and survival of MSS will undoubtedly depend on it. A lot was made in WARC 87 of the "great compromise" praised by so many of us that were there. Was it really a great compromise or was it that INMARSAT suddenly realized, in mid conference, that it had just as much to gain and perhaps more by agreeing to selective change? We may never really know! One thing is certain; we must never again allow MSS viability to be subject to uncertainty and last-minute compromises.

The Moment of Truth

For all the things that went right or wrong North American MSS implementation is only a few years away and yet several major issues need still to be addressed and resolved. Bilateral issues such as transborder service, licensing and type approval must be addressed; Difficult multilateral spectrum coordination deliberations must be completed; and above all the perception of a viable and expanding service offering must be maintained and enhanced through further mobile satellite allocations in 1992.

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